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Dated 5 June 2003

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27 JUN 2002

NEWPORT

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1. Your reference

P/6762

2. Patent application number

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0214862.5

27 JUN 2002

3. Full name, address and postcode of the or of each applicant (underline all surnames)

1) 8349532001

2) 7460603001

3) 5615224002

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

- 1) CNH U.K. Ltd., Cranes Farm Road, Basildon, ESSEX SS14 3AD
- 2) Iveco (UK) Ltd, Iveco Ford House, Station Road, Watford, HERTS WD1 1SR
- 3) Cummins Engine Company Limited, Yarm Road, Darlington, County Durham DL1 4PW

All three British companies.

4. Title of the invention

Engine Timing

5. Name of your agent (if you have one)

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

A. Messulam & Co. Ltd  
43-45, High Road  
Bushey Heath  
Herts WD23 1EE

Patents ADP number (if you know it)

07636210001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)

Date of filing  
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

c) any named applicant is a corporate body.

See note (d))

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Continuation sheets of this form

Description

7

Claim(s)

2

Abstract

1

Drawing(s)

2

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

1

Request for substantive examination (Patents Form 10/77)

Any other documents  
(please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature

Date

*A. Messulam*

26 June 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

A. Messulam Tel: 020 8421 8197

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# ENGINE TIMING

## Field of the invention

5       The present invention relates to engine timing.

## Background of the invention

10       When assembling and repairing engines, it is important  
to achieve precise synchronisation between the operation of  
various mechanical components. For example, the timing of  
the operation of the cams that actuate the intake and  
exhaust valves of any engine or the timing of the operation  
of the injectors of a fuel injection pump in a compression  
15   ignition (diesel) engine are crucial for correct engine  
operation.

Engines can be designed so that the crankshaft driven  
cogs that drive ancillary equipment, such as the mechanical  
20   fuel injection pump of a diesel engine, are located either  
at the front end or the rear end of the engine. When the  
drive cogs are arranged at the front of the engine, they can  
be accessed relatively simply and proper timing can be set  
by ensuring that timing marks that are provided for this  
25   purposes on the various cogs line up with one another.

However, when ancillary equipment is driven by cogs at  
the rear of the engine, the transmission fitted to the  
engine prevents the drive cogs from being inspected or  
30   accessed and this makes it difficult to guarantee that  
ancillary equipment, such as a fuel injection pump, is  
refitted with the correct timing after it has been removed  
for servicing.

### Object of the invention

The present invention seeks therefore to enable precise location of an engine crankshaft during engine servicing to permit ancillary equipment to be fitted to the engine with correct timing.

### Summary of the invention

10 According to a first aspect of the invention, there is provided a method of positioning the crankshaft of an engine having a flywheel fitted to the engine crankshaft, the method comprising the steps of:

providing a first hole in the flywheel,  
15 providing a second hole in a stationary part of the engine to line up accurately with the hole in the flywheel once during each crankshaft revolution,

manually cranking the engine until the holes in the flywheel and the engine are aligned, and

20 inserting a locking pin into the aligned holes to lock the crankshaft in a predetermined angular position.

Where the flywheel has external teeth that are engaged by the driving cog of an electrical starter motor, the step  
25 of manually cranking the engine preferably comprises:

removing the starter motor,  
mounting on the engine using the same mounting surface as the starter motor a manual cranking device having a cog that meshes with the teeth on the flywheel and that is  
30 secured to a shaft rotatable by means of a cranking handle, and

rotating the flywheel by means of the cranking handle to position the flywheel.

35 Advantageously, the hole in the engine that receives the locking pin is located in such a manner as to prevent

replacement of the engine starter motor while the locking pin is in place in the aligned holes.

To assist in alignment of the holes and insertion of the locking pin, it is preferred to form the hole in the flywheel so that it is not normal to the end surfaces of the flywheel.

According to a second aspect of the invention, there is provided an internal combustion engine having

- a crankshaft,
- a toothed flywheel mounted on the crankshaft,
- a starter motor have a driving cog that meshes with the teeth of the flywheel,
- a housing enclosing the flywheel,
- a first hole formed in the flywheel, and
- a second hole formed in the housing to line up accurately with the hole in the flywheel once during each crankshaft revolution,

wherein the hole in the housing is covered by the starter motor and is only accessible after removal of the starter motor.

In a further aspect of the invention, there is provided a manual cranking device for use with an engine as set forth above, comprising:

- a casing for mounting to the engine in place of the starter motor,
- a shaft journaled in the casing,
- a cog fast in rotation with one end the shaft for meshing with the teeth of the engine flywheel, and
- a connector at the other end of the shaft for receiving a cranking handle to permit the flywheel to be cranked manually,

the casing being shaped to avoid obstruction of the hole in the flywheel housing so as to permit a locking pin to be inserted into and removed from the aligned holes in

the flywheel and the housing while the cranking device is fitted to the engine.

In a two-stroke engine, it suffices to ensure that the crankshaft is in a predetermined position when setting the timing of ancillary equipment. In a four-stroke engine, it is of course additionally necessary to ensure that the engine is operating in the correct stroke. For example, if the holes in the flywheel and housing line up at top dead centre of a given engine cylinder, it is additionally necessary to be able to ascertain if the piston has just completed the compression stroke or the exhaust stroke.

To ensure that a four-stroke engine is operating in the correct stroke, it is possible to provide a timing marking on a camshaft that is rotated at half engine speed and to inspect the position of the timing mark prior to locking the crankshaft by inserting a locking pin into the aligned holes in the flywheel and the flywheel housing.

A dedicated inspection window may be provided to view the timing marks on the camshaft. However, in some engines, a lobe is provided on the camshaft to operate a mechanical fuel pump and in this case the timing markings may be provided near the cam lobe that operates the fuel pump. In such a case, without the additional expense of a dedicated inspection window, it is possible to determine the position of the camshaft by removal of the fuel pump, a task that can be performed simply and quickly.

#### Brief description of the drawings

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side view of a diesel engine for an agricultural vehicle,



Figure 2 is a detail of the engine of Figure 1 showing the mounting surface for the starter motor after the starter motor has been removed,

Figure 3 is an exploded perspective view of a  
5 mechanical cranking device for mounting in place of the engine starter motor to enable the engine flywheel to be cranked manually,

Figure 4 is a perspective view of the cranking device of Figure 3 in its assembled condition,

10 Figure 5 is a view similar to that of Figure 2 showing the cranking device mounted on the engine, and

Figure 6 is a perspective view with part of the engine cut-away showing a locking pin inserted into a hole in the flywheel to prevent rotation of the crankshaft.

15

Detailed description of the preferred embodiment

Figure 1 shows an engine 10 having a starter motor 12 that is secured to the rear of the engine on a mounting  
20 surface 14. Figure 1 shows the starter motor withdrawn from its normal position to expose the mounting surface 14 which has three holes 16 to enable the starter motor 12 to be bolted in position during normal operation.

25 The mounting surface 14 and the holes 16 are better seen in Figure 2 in which it is also possible to see part of the flywheel 18 that is bolted on to the engine crankshaft. The flywheel 18 has external teeth 20 that mesh with a cog of the starter motor 12 to enable the engine to be cranked  
30 by the starter motor. The flywheel has a marking 22 which when lined up with a marking 24 on the mounting surface 14 indicates that the first engine cylinder is near TDC. When the crankshaft is exactly at TDC, a hole in the flywheel (not shown) lines up precisely with a hole 26 formed in the  
35 starter motor mounting surface 14.

When mounting ancillary equipment, such as a diesel fuel injection pump, that needs to be accurately timed in relation to the crankshaft, the engine is rotated manually, as is described below, to align the hole 26 with the corresponding hole formed in the flywheel. A locking pin (designated 68 in Figures 5 and 6) is inserted into the hole 26 and the hole in the flywheel 18 to lock the crankshaft in the TDC position of the first engine cylinder. If the engine is a four stroke engine, it can be ascertained that the cylinder is at the end of the correct stroke by examining timing markings on a camshaft that turns with the crankshaft at half the engine speed. Most simply, this can be effected by providing timing markings near a lobe of the camshaft that drives a mechanical fuel pump, as the timing marking can then be seen by simple removal of the fuel pump.

With the crankshaft firmly locked, as shown in Figure 6, in a position in which the first cylinder is exactly at the top dead centre of its compression stroke, ancillary equipment can be removed for servicing. To guarantee correct timing, it is only necessary to ensure that the ancillary equipment is subsequently replaced in the same orientation as when it was removed.

To turn the engine manually, a cranking device as shown in Figures 3 to 5 is bolted on to the mounting surface 14 for the starter motor. The cranking device 40 comprises a casing 50 having a mounting flange 52 similar to that of the removed starter motor with bolt holes 54 that line up with the holes 16 in the mounting surface 14. A shaft 56 is journaled in the casing 50 and is fast in rotation at one end with a cog 58 that meshes with the teeth of the flywheel 18. The shaft 56 is retained in the casing 50 by means of a clip 60 received in an annular groove 62 in the shaft 56 and the opposite end of the shaft 56 has a hexagonal head 64 to enable it to be turned by means of a suitable cranking handle or a wrench 66 that incorporated a ratchet mechanism.

After removal of the starter motor, the cranking device 40 is bolted to the engine and this enables the flywheel to be turned by means of the cranking handle 66. The length of the handle and the high gearing ratio between the cog 58 and the flywheel 18 ensure that little effort is required to rotate the crankshaft. When the first engine cylinder reaches TDC at the end of its compression stroke, the hole in the flywheel 18 lines up with the hole 26. A locking pin 68 (which may have a tapered end to facilitate its location and insertion) is then driven through the hole 26 into the flywheel to lock the crankshaft in the TDC position, as shown in Figure 6.

The position of the hole 26 in the mounting surface 14 for the starter motor offers the advantage that no special steps need be taken to seal the hole 26 during normal engine use as it is covered by the mounting flange of the starter motor. Furthermore, the protruding pin 68 prevents the starter motor from being remounted on the engine so that there is no risk or danger of an attempt being made to operate the engine with the locking pin 68 still in place.

It will also be noted that the hole 26 is arranged at an angle to the flywheel 18. This makes it easier to see when the holes are aligned and also affords better access for insertion of the locking pin 68.

CLAIMS

1. A method of positioning the crankshaft of an engine having a flywheel fitted to the engine crankshaft,  
5 the method comprising the steps of:  
    providing a first hole in the flywheel,  
    providing a second hole in a stationary part of the engine to line up accurately with the hole in the flywheel once during each crankshaft revolution,  
10 manually cranking the engine until the holes in the flywheel and the engine are aligned; and  
    inserting a locking pin into the aligned holes to lock the crankshaft in a predetermined angular position.
- 15 2. A method as claimed in claim 1, when used in an engine of which the flywheel has external teeth that are engaged by a driving cog of an electrical starter motor, wherein the step of manually cranking the engine comprises:  
    removing the starter motor,  
20 mounting on the engine using the same fixings as the starter motor a manual cranking device having a cog that meshes with the teeth on the flywheel and that is secured to a shaft rotatable by means of a cranking handle, and  
    rotating the flywheel by means of the cranking handle  
25 to position the flywheel.
3. A method as claimed in claim 2, wherein the hole in the engine that receives the locking pin is located in such a manner as to prevent replacement of the engine  
30 starter motor while the locking pin is in place in the aligned holes.
4. A method as claimed in any preceding claim, wherein the hole in the flywheel is formed so that it is not  
35 normal to the end surfaces of the flywheel.

5. An internal combustion engine having  
a crankshaft,  
a toothed flywheel mounted on the crankshaft,  
a starter motor have a driving cog that meshes with the  
5 teeth of the flywheel,  
a housing enclosing the flywheel,  
a first hole formed in the flywheel, and  
a second hole formed in the housing to line up  
accurately with the hole in the flywheel once during each  
10 crankshaft revolution,  
wherein the hole in the housing is covered by the  
starter motor and is only accessible after removal of the  
starter motor.

15 6. A manual cranking device for use with an engine as  
claimed in claim 5, comprising

a casing for mounting to the engine in place of the  
starter motor,

a shaft journaled in the casing,

20 a cog fast in rotation with one end the shaft for  
meshing with the teeth of the engine flywheel, and

a connector at the other end of the shaft for receiving  
a cranking handle to permit the flywheel to be cranked  
manually,

25 the casing being shaped to avoid obstruction of the  
hole in the flywheel housing so as to permit a locking pin  
to be inserted into and removed from the aligned holes in  
the flywheel and the housing while the cranking device is  
fitted to the engine.

30 7. A method of positioning the crankshaft of an  
engine substantially as hereinbefore described with  
reference to and as illustrated in the accompanying  
drawings.

ABSTRACT

ENGINE TIMING

5        A method is disclosed for positioning the crankshaft of  
an engine. The method comprises the steps of providing a  
first hole in the flywheel 18, providing a hole 26 in a  
stationary part of the engine to line up accurately with the  
hole in the flywheel 18 once during each crankshaft  
10 revolution, manually cranking the engine until the holes in  
the flywheel and the engine are aligned, and inserting a pin  
68 into the aligned holes to lock the crankshaft in a  
predetermined angular position.

15

Figures 2 and 5

1/2

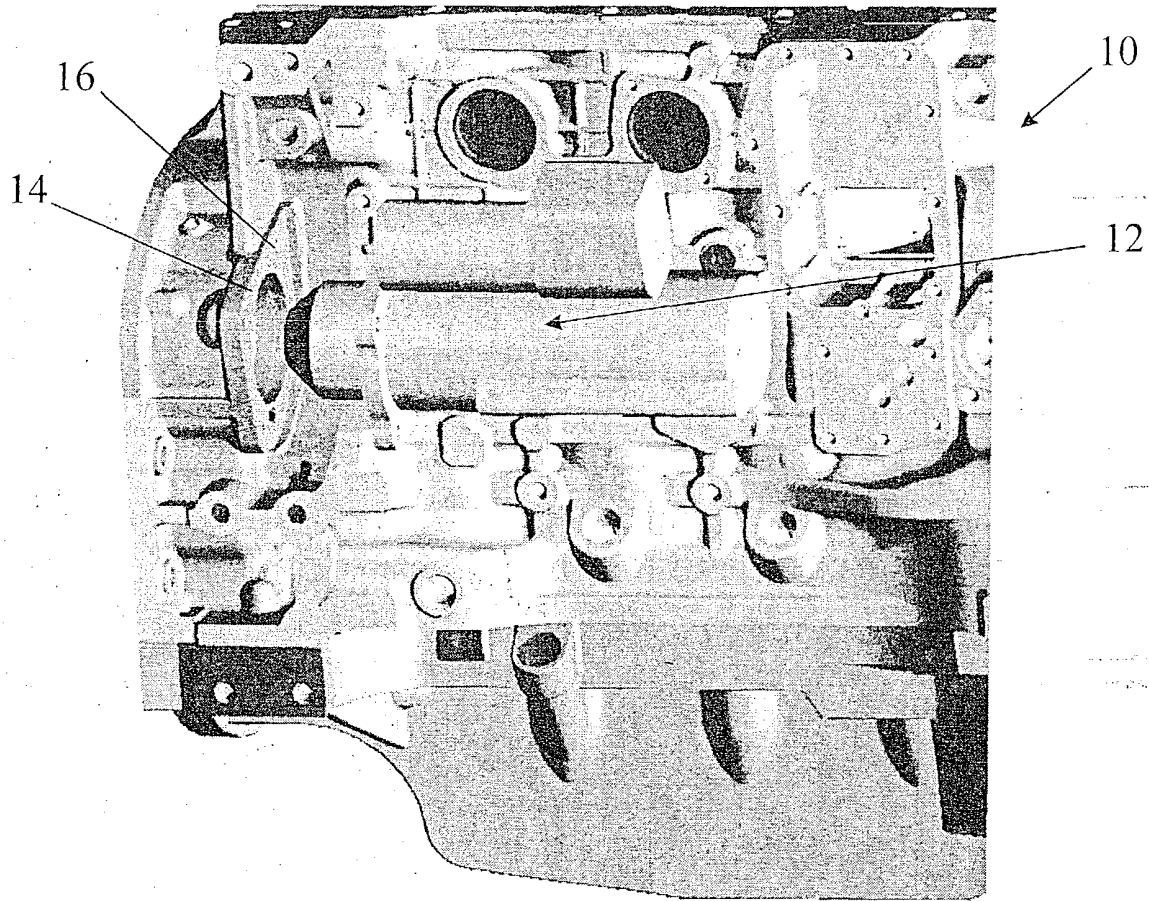


Fig. 1

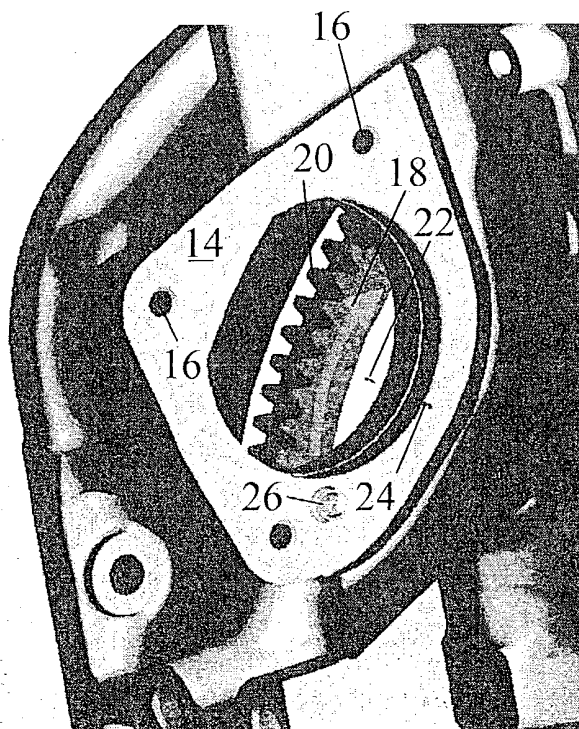


Fig. 2





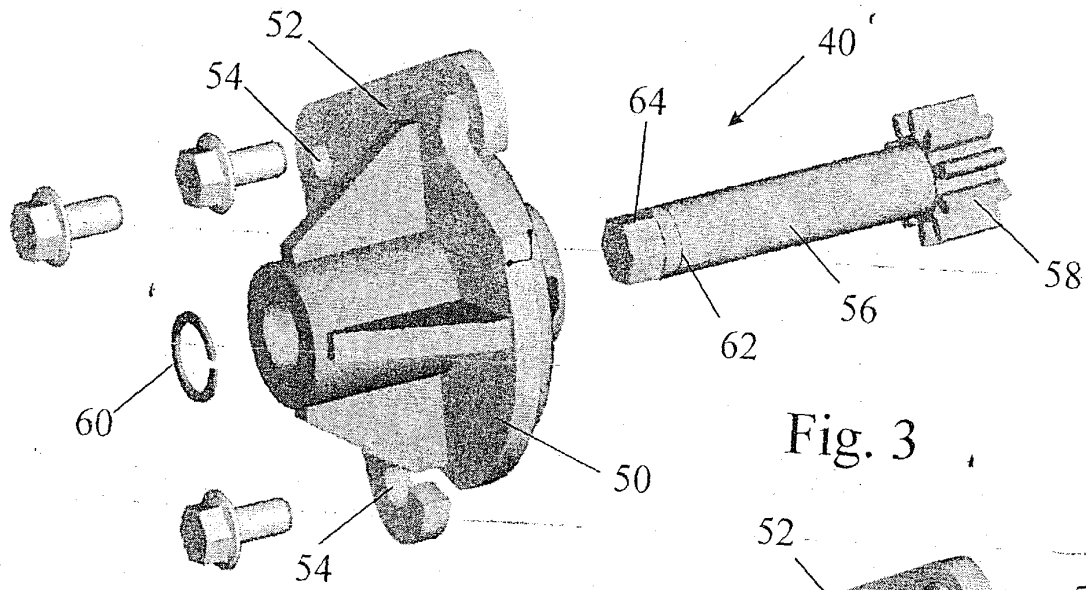


Fig. 3

Fig. 5

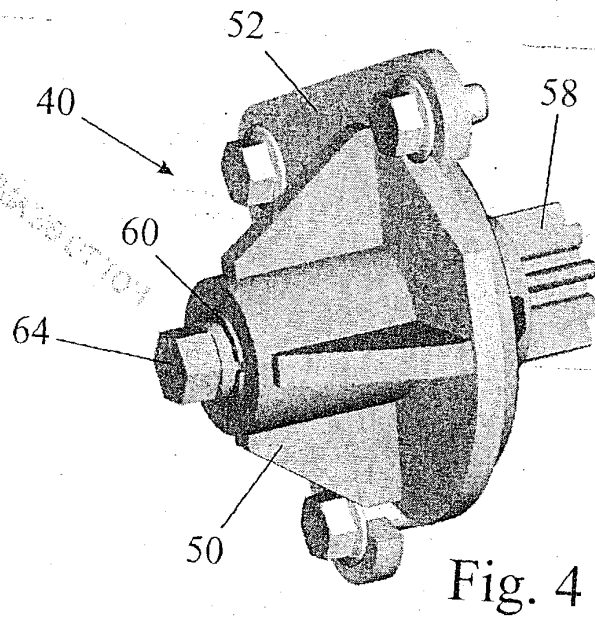
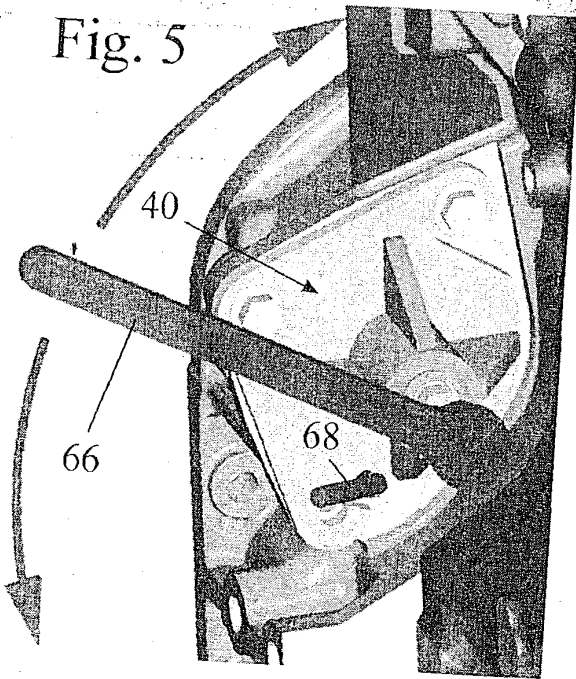


Fig. 4

Fig. 6

